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EUROPE MAKES EXTENSIVE USE OF ERS-1 GLOBAL RESOURCES SATELLITE

Li Xing

According to reports, Europe's most advanced global observation satellite, that is, the European Space Agency (ESA) Global Resource Satellite-1 (ERS-1), is capable--from approximately 780km altitude--of detecting objects on the surface of the earth to 1 cm accuracies in moving situations. This will produce important stimulative effects with regard to research on the plate structure of the earth as well as the work of earthquake prediction.

This ERS project--with a price of 860 million U.S. dollars--is a large scale multinational astronavigational project of Europe's. The ERS-1 satellite has a weight of 2.5 tons and is built by a financial consortium with the German Space Flight Company at its head. A good deal of important equipment is supplied by the U.K., France, Italy, and Spain.

Recently, results have already been announced for the first batch of research carried out making use of this satellite. In this is included:

--Important data used in the study of plate structure obtained by a German-Italian scientific research team associated with Bonn University. Research personnel deployed a good number of radar reflectors in an area in the vicinity of Bonn. The synthetic aperture radar (SAR) on the ERS-1 satellite carried out multiple iterations of imagery with respect to these reflectors. Through the reflector position differences which were obtained, it was then possible to precisely determine movement data associated with plates coming out of the earth's crust.

--Utilization of interference measurement techniques to make terrain imagery. The use of SAR interference measurement data is currently opted for by a good number of European and U.S. users. A scientific research team associated with Switzerland's Sulishi (phonetic) University and NASA's Jet Propulsion Laboratory has already gone through an evaluation of backward scattering signals from the two times when ERS-1 went through the Tananuo (phonetic) river area in U.S. Alaska, constructing a precise mathematical terrain model diagram. Moreover, making use of computers, a 3 dimensional map of the area in question was made.

--The U.K. Mullard Space Science Laboratory made use of ERS satellite radar altimeter data mapping to make the most accurate terrain map of the South Pole to date. It should be pointed out that collecting data related to the South Pole is the ERS satellite's main objective. Germany and Japan have already set up ERS ground stations on the mainland at the South Pole.

--Making use of radar imagery to monitor pollution has obtained better results than expected. Scientific teams associated with Norway, Holland, the U.S., and Japan are just in the midst of making estimates with regard to ERS-1 satellite determinations of pollution models and pollution levels.

--One U.S. research worker--after studying ship wakes in the Alaska and Los Angeles areas--discovered that even if ships only generated small amounts of leaking oil (or intentionally discharged small amounts of oil), on ERS radar imagery, it was

possible to display it in all cases. Norwegian scientists made tests on small amounts of petroleum released into the oceans. The results clearly showed that--under appropriate conditions--ERS-1 satellite radar was capable of imaging an oil film with a thickness of 1 molecule on the surface of the water.

--Use is made of ERS-1 to carry out weather research. The U.S. National Oceanic and Atmospheric Management Bureau has made use right along of ERS pulse radar altimeter data to calculate the influences of El Nino currents on the oceans. Research clearly shows that--at intervals of each 3-7 years--El Nino currents continuously appear for approximately 6 months. During this period, there will be the appearance of bad weather--for example, Australian drought, Chilean rainstorms, as well as violent wind storms in the Pacific, and so on. During a weather research project related to the South Pole, ERS satellite data was used to carry out studies of the mutual influences of the sea ice of the Weddell Sea, the oceans, and the atmosphere. This is one of the important foundations for the setting up of weather models.

--Holland made use of ERS altimeter data to make detailed maps of the entire sea bottom of the Atlantic Ocean. Danish scientists made use of radar data to precisely determine for the first time topographical data for the sea floor in the area of the North Pole.

--French scientists made use of satellite radar data to calculate precise sea bottom topographic data for the different regions of the South Pacific, and the North and South Atlantic.

Research results obtained by making use of the ERS satellite also include:

--Undercurrents: ERS satellite radars have already carried out imaging with respect to large scale undercurrents moving under water through the Straits of Gibraltar. Undercurrents are formed because of different densities and salinities produced when sea water at different temperatures is mixed together. Making use of current space based optical sensors, it is still not possible to clearly detect these undercurrents.

--Oceanic Topography and Temperatures. Norway has already carried out ERS imagery with regard to oceanic currents in the vicinity of Norway. In conjunction with this, comparisions were made between the imagery obtained and oceanic temperature data obtianed from high resolution radiometers associated with the U.S. Tyros satellite. As far as the results are concerned, it was discovered that oceanic surface characteristics as well as the forms of changes associated with radar imagery and the artificial color images displaying temperature differences associated with Tyros satellite data are almost the same.

--Related Wind Data. 3 long 2.3-3.6 meter wind field scattering instrument antennas mounted on the top of the main radar are in the midst of supplying precise wind speed and wind direction data for the whole earth. At present, these data are just being used together with other data in order to make weather prediction models.

--Temperature Data. Temperature data supplied by ERS longitudinal scan radiometers developed by the U.K. are capable of mapping out oceanic surface temperature diagrams accurate to within a few tenths of a degree (absolute temperature).

--Making Use of Satellite Radar Data in Order to Carry Out Multiple Types of Land Utilization Research. Currently, extremely accurate data associated with the utilization of sea, sea coast, and large areas of land as well as changes in agricultural crops have already been obtained for Germany's Baltic. A European Community committee has already taken imagery associated with the felling of tropical rain forest and used it in research on tropical ecological environments.

THE FORMER SOVIET UNION'S REMOTE SENSING SATELLITE PROJECTS REVISITED

Li Zhong

On 31 March, 1991, at the Kebainuer (phonetic) firing range, the Soviet Union used a Proton rocket to launch a satellite called Diamond 1. This satellite is a large scale space observation platform. The Diamond 1 was originally set for launch in the middle of 1990. For technical reasons, it was postponed the first time to the end of 1990. After that, it was delayed until 1991. After launch, the Diamond 1 first of all entered into an initial orbit of 162-255km. After going through a series of maneuvers from 2-4 April, the satellite finally entered into an orbit of 269-281km. Satellite orbit angle of inclination is 72.7°. This is the maximum angle of inclination the Proton rocket reaches. The actual orbit altitude of the Diamond 1 and the latter period flight altitude of the former Soviet Union's first radar satellite--Cosmos 1870--are basically the same.

Cosmos 1870

Cosmos 1870 was launched on 25 July 1987. The initial orbital altitude was 157-228km. Angle of inclination was 71.9°. Four days later, Cosmos 1870 went through a series of maneuvers to enter into a movement orbit of 244-259km.

On 17 September 1988, rose in altitude and entered into a higher orbit of 262-277km. From 30 June - 1 July 1989, the final satellite orbit was adjusted to 261-287km. On 29 July in the same year, the satellite began to drop out of orbit. As far as reports in the former Soviet news media are concerned, the initial orbital weight of the Cosmos 1870 was 18550kg (Because the orbital angle of inclination was relatively large, as a result, this was 20 tons less than the actual lifting capability of the Proton rocket). Assuming that minimum energy is used in order to carry out maneuvers, during flight processes, the overall speed changes is 400m/sec. This means that the weight of the fuel that is carried must reach 2.4 tons. This also includes in it fuel used in atitude control.

When the former Soviet Union's Cosmos 1870 was launched, it was only announced that the satellite would carry out remote sensing missions. The equipment it carried was used to implement observations of the suface of the globe and the world's oceans and seas. Later, it was also declared that what the Cosmos 1870 carried was a radar station used to carry out all weather obesrvations of the surface of the globe and the oceans and seas. According to releases from former Soviet news circles in 1988, the Cosmos 1870 satellite development work had already been completed early in July 1981. However, due to the person in charge of the design bureau and the defense department chief not getting along at that time, launch plans were abandoned. All work on the Diamond project was forced to stop. As luck would have it, in December 1984, the design bureau chief and the defense department head both died one after the other. In the second year after their deaths--that is, 1985--the first Diamond remote sensing satellite went

through test measurements. However, when launched in 1986, the satellite did not go into orbit. As a result, it was only in July 1987 that it was launched into space acting as a reserve satellite.

The situation relating to the Cosmos 1870 was only disclosed in various international conferences when the former Soviet Union was preparing to market space based remote sensing facilities. The Cosmos 1870 was designed on the foundation of the Salute Gun space station--only it did not provide a docking entrance for the manned Union spaceship. In fact, the Cosmos 1870 was nothing else than the Salute Gun space station. It was just that it did not have cosmonauts on it, and it was fitted with a completely new set of equipment--that is all.

The volume of the Cosmos 1870 was 90 cubic meters. It was capable of carrying a 4 ton weight of instruments and equipment. Within sealed compartments, it was filled with air or nitrogen gas. The gas pressure was one standard atmosphere. Temperature, by contrast, was controled at 5-35°C. Accuracy was ±1°C. The outside of the satellite had two large solar energy panels capable of supplying 27.5±0.5 volts. The average power was 2400 watts of electricity. However, transient peak powers were capable of reaching 7500 to 10000 watts.

Along the length of the satellite, there are two wave guide radar imagery systems. Overall antenna system length is 15 meters. Width is 1.5 meters. Its operating wave length is 10 cm. Pulse sustainment period is 0.1 microseconds. Power is 190kw. Repetition frequency is 3000Hz. Surface resolution is 25-30 meters. Surface imagery width is 25-30km. Single image lengths are 20-250km. The area it is possible to image is within a range from 30°-60° figured from the nadir of the satellite. When the orbital angle of inclination is 72°, the satellite is capable of carrying out imaging in an area between 78° N.Lat and 78° S.Lat.

Research projects during the two years of Cosmos 1870 orbital flight include:

1. Oceanography: studying waves on the surface of the sea, wave front peaks, vortices and circulation, the movements of oceanic currents, interior wave surface images, continental shelf irregularities, oceanic surface pollution, boundaries of tides and floods;

2. Earth Sciences: geological strata structures associated with descriptive and dynamic geology;

3. Agriculture and Land Utilization: use of radar to carry out land and arable land mapping, collection of information associated with amounts of crops produced and soil moisture, regional land and forest boundary lines.

Cosmos 1870 attitude is controled by attitude control /20 engines and gyroscopes. It is already known that the former Soviet Union made use of gyroscopes on large model satellites called "Cosmos", on the Peace space station, as well as militay orbital stations--that is, Salute Gun 3 and 5. However, on civilian Salute Gun orbital stations--that is, Salute Gun 1,4,6,and 7--no use is made. Each gyroscope weighs 165kg. They rotate 10000 turns per minute. The purpose of using gyroscopes lies in saving fuel.

Diamond 2

According to plans at the present time, Diamond satellites are to be launched approximately 5 times. There was a launch failure in 1986. In July 1987, Cosmos 1870 was launched. In March 1991, Diamond 1 was launched. In conjunction with this, it reentered in October of last year. Diamond 1B is planned to be launched in 1993-1994. In 1995-1996, it is planned to launch improved Diamond satellites.

Diamond 1 and Cosmos 1870 are different. The satellite in question is not only capable of sending data directly back to the surface. It is also capable of going through communications satellites--that is, Loutch/SDRN geosynchronous satellites--to relay data. These communications satellites will be launched during the same period as the Diamond satellites. They are positioned at 95°E (SDRN-TS), 20°W (SDRN-V), and 164°W (SDRN-Z). By January 1992, as far as the three communications satellites are concerned, two were already in operation (SDRN-TS,-Z). The gap associated with SDRN-V has still not been filled.

Compared to Cosmos 1870, the performance of Diamond 1 has already been relatively greatly improved. Surface resolution is 15-30 meters. In actuality, it has already reached 11-15 meters. The fixed field of view associated with carrying out photographic imagery is 20-45km. The range of the sweep associated with the next iteration of imagery is 2x350km. Repetition rates and pulse powers are the same as Cosmos 1870--respectively, 3000Hz and 190kw. Detection pulse periods are 0.1 microseconds or 0.07 microseconds. Average output power is 80 watts. Data acquired by Diamond 1 is stored by recording devices on board the satellite. Recording device recording time periods have already been increased to 150 seconds.

The unexpected problem which Diamond 1 encountered is that air resistance created by solar activity is greater than imagined beforehand. During the entire year of 1991, the satellite required constant altitude adjustments, thus lowering the satellite life in orbit. According to reports, this flight iteration was only sustained until December 1992 and not close to 30 months as originally predicted.

Possibility of Modification

Even though the Diamond design plan has already been determined, there is, however, a continuous search for international cooperation in relevent areas in order to seek out improvements to carry out on Diamond 2. Among these, one possible design modification is to use a Progress type spaceship to carry out in-orbit refueling on Diamond satellites.

In accordance with disclosures at the 1991 international astronavigational association general meeting (IAF)--after improvements--the Diamond 2 satellite will be launched by the improved Proton rocket in 1995-1996. The Diamond 2 useful load is

6.5 tons. Among the instruments it carries are 3 synthetic aperture radars. Besides that, there are various types of spectrographs. Diamond 2 will be made use of to act as an ecological monitoring platform. Orbital altitude is 600km. Angle of inclination is 73°. Flight life is 5 years.

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